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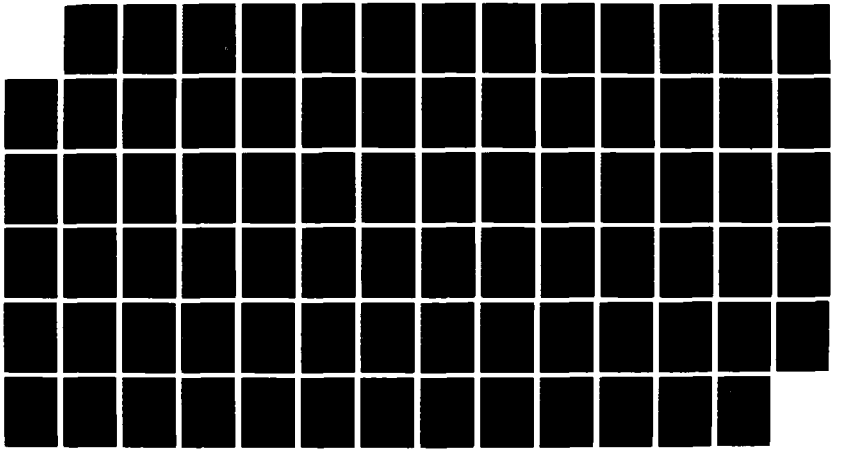

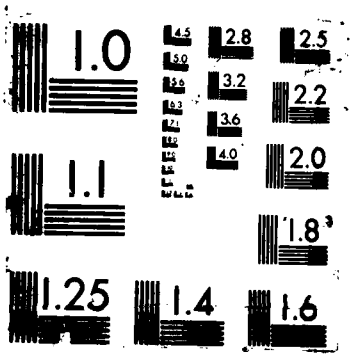
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COMMUNICATIONS-ELECTRONICS (C-E) SYSTEM: DATA QUALITY PARAMETERS

by

Desmatics Staff

— STATISTICS —

— OPERATIONS RESEARCH —

— MATHEMATICS —

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Applied Research in Statistics - Mathematics - Operations Research

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TECHNICAL REPORT NO. 118-12

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This report documents the results of the second phase of a two-part study. The first part of the study investigated the quality of the data produced by the C-E system in Fy83 and FY84. The second part of the study, discussed in this report, dealt with the development of parameters for use in designing automated screening procedures to monitor C-E system data quality. Although the system is currently processing data as intended, a number of recommended enhancements remain to be implemented. Because these enhancements will require substantial changes in the current system logic, automated

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monitoring of C-E output data is neither appropriate nor feasible at this time. Desmatics has, however, provided a discussion of monitoring techniques which can be implemented once the system becomes fully stabilized,

EXECUTIVE SUMMARY

Desmatics, Inc., under Contract No. F33600-82-C-0466, is conducting an evaluation of the Communications-Electronics (C-E) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Costs system. The C-E system, ~~D160A~~, collects and displays Operating and Support ~~(O&S)~~ costs for items of ground communications-electronics, and meteorological equipment.

This report documents the results of the second phase of a two-part study. The first part of the study investigated the quality of the data produced by the C-E system in FY83 and FY84. The second part of the study, discussed in this report, dealt with the development of parameters for use in designing automated screening procedures to monitor C-E system data quality.

Although the system is currently processing data as intended, a number of recommended enhancements remain to be implemented. Because these enhancements will require substantial changes in the current system logic, automated monitoring of C-E output data is neither appropriate nor feasible at this time. Desmatics has, however, provided a discussion of monitoring techniques which can be implemented once the system becomes fully stabilized.

Successful quality control in any system requires the effective monitoring of input data for abnormal variability. Although the current status of the C-E system also affects the extent of effective input monitoring which can be achieved at this time, some useful but limited screening at this level is nevertheless possible.

Inputs to the C-E system consist of a set of four tables maintained by the Office of VAMOSC, and files originating from nine AF data systems. Desmatics has developed a more efficient method for updating the tables. For

a number of the system inputs, Desmatics has outlined monitoring procedures for detecting errors or identifying anomalous data. Once automated, these procedures can be incorporated into the current logic of the C-E system. For the remaining system inputs, Desmatics has discussed the major factors which make it inadvisable to design or implement monitoring procedures at this time.

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TABLE OF CONTENTS

I. INTRODUCTION

Desmatics, Inc., under Contract No. F33600-82-C-0466 is conducting an evaluation of the Communications-Electronics (C-E) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Costs system. The C-E system is designed to provide Operating and Support (O&S) costs for Ground Communications-Electronics and Meteorological (CEM) equipment at the Type-Model-Series (TMS) level in nineteen cost categories. The current investigation calls for 1) an identification of significant anomalies in recent C-E data, and 2) the development of data quality parameters for monitoring C-E system data quality.

This report deals with the second phase of this study: the development of parameters for monitoring C-E system data quality. These parameters are for use in automated screening procedures to be developed for monitoring the quality of C-E output data. The Statement of Work specifically calls for Desmatics to develop a set of parameters based on the findings of the data anomaly study, the first phase of this effort. This recently completed phase was based on C-E system data from FY83 and FY84. The results are documented in Desmatics Technical Reports No. 118-10 [11] and No. 118-11 [12], respectively.

As in any information system, both input data and processing errors can have a serious impact upon the quality of system outputs. A number of such errors were uncovered during the initial phase of this investigation. For the most part, the processing errors identified have been corrected, and for the FY85 run, data was being processed in the C-E system as intended. However, the system cannot be regarded as fully operational at this time because a

number of the cost allocation algorithms and the associated processing logic require extensive modification. In addition, some data inputs are inadequate. Detailed discussions of these topics are given in previous Desmatics reports [4-9].

The deficiencies in algorithms, logic, and inputs so seriously impact the quality of the current output products that it would be premature to attempt at this time to monitor any data at this level. Therefore, the current study phase has of necessity focused primarily on data inputs which do exhibit apparent anomalies affecting C-E output products, and which can be monitored effectively at this time.

Although, as noted, it is premature to establish procedures for monitoring C-E data quality at the end product level, Desmatics has provided a discussion of statistical techniques applicable to this type of monitoring. These techniques can be utilized once the system becomes fully operational. This discussion is given in Section II.

Section III, which deals with C-E system inputs, describes monitoring procedures that can be implemented at the present time. A number of anomalies in the system inputs were uncovered in the first phase of this study [11,12]. Each interface which can be monitored for anomalies before it is processed in the C-E system is discussed in a separate subsection. Wherever possible, internal monitoring of the C-E system in further processing of any of these inputs is addressed as well. The difficulties associated with monitoring the remaining inputs are also discussed.

References are listed in Section IV. The appendix contains a description of the allocation algorithms used to develop the costs currently portrayed on the C-E O&S Cost Report. These descriptions, which provide an update to those

given in the 1982 C-E User's Manual [24] (currently under revision) reflect the status of the C-E system algorithms just prior to processing FY86 data. A revision of the system flow charts for the C-E System Specification Manual [15], reflecting the status of the system at that time, was completed just prior to this run, and are the ones referred to throughout this report.

II. MONITORING C-E OUTPUT DATA

The C-E system is a multi-input, multi-output information system designed to provide O&S cost information for ground CEM equipment. The C-E system is designed to produce 19 categories of O&S cost information for hundreds of equipments ranging in complexity from a telephone to a satellite tracking set.

As in any information system, data input and processing errors can have a serious impact upon the quality of the system outputs. As part of its evaluation of the C-E system, Desmatics has been actively involved in identifying input and processing errors at various points in the C-E processing network. The present discussion focuses on statistical techniques for monitoring output data quality.

There are three levels of analysis at which to monitor output data. The first, and simplest, level is restricted to an individual TMS across a number of years. The second level uses information between TMSs in a single year. The third, and most detailed level, uses information between TMSs across a number of years.

To facilitate the data quality analysis (regardless of the analysis level), edit checks should be developed and implemented in the C-E system to ensure against logical impossibilities in the output data. The implementation of additional, more sophisticated quality control procedures should therefore provide increased data quality enhancement.

To establish some notation, let C_{ijk} denote the per item O&S cost associated with the ith cost category in the jth year for the kth TMS. Let

$$C_{.jk} = \sum_{i=1}^{19} C_{ijk}$$

denote the total O&S cost for the kth TMS in the jth year, and let

$$R_{ijk} = [C_{ijk} - C_{i(j-1)k}]/C_{i(j-1)k}$$

denote the difference in C_{ijk} relative to the cost the previous year.

A. ANALYSIS OF AN INDIVIDUAL TMS ACROSS YEARS

At this level of analysis, a large relative increase or decrease (R_{ijk}) in any given cost category from one year to the next would qualify as a potential data anomaly. In calculating R_{ijk}, the costs C_{ijk} should probably be adjusted for inflationary effects. Consequently, if there is no real change from one year to the next, R_{ijk} should be zero or nearly zero. In general, however, $R_{ijk} \geq -1$ since O&S costs are nonnegative.

In order to determine which R_{ijk} values are particularly small or excessively large, each R_{ijk} could be compared with corresponding ratios from previous years. For example, (R_{i1k}, R_{i2k}, ..., $R_{i(j-1)k}$) could be used to statistically establish a range of acceptable variation (i.e., limits of normal variability) for an observed R_{ijk} value. There are many standard statistical techniques for screening outliers in this manner. See, for example, Barnett and Lewis [10].

A major difficulty in implementing this procedure is the lack of comparison data for the R_{ijk} corresponding to those years initially examined,

in particular for j=1. Accordingly, without the benefit of empirical data upon which to base an objective outlier and data quality analysis, it will be necessary, at least initially, to incorporate expert judgement or opinion into the data screening process. Of course, once an adequate data base is established, the use of expert opinion can be reduced or eliminated, if so desired.

In addition to basing the data quality analysis on the R_{ijk}, it can also be based on the proportions of total O&S cost represented by the various cost categories. More precisely, define

$$P_{ijk} = C_{ijk}/C_{.jk}$$

and note that

$$0 \leq P_{ijk} \leq 1$$

and

$$\sum_{i=1}^{19} P_{ijk} = P_{.jk} = 1$$

A significant change in the P_{ijk} from the previous year would signal a potential data anomaly. Of course, this analysis procedure is meaningful only if the amount of change in total O&S cost for the year in question is within reasonable limits. Much of the previous discussion concerning screening the R_{ijk} factors for data anomalies also applies to screening the P_{ijk} factors.

Finally, the use of a multivariate approach at this level of analysis

would be of limited practicality. The large number of cost categories and the fact that year-to-year data for the same TMS may not be statistically independent would clearly require a very extensive data base in order for any mulitivariate method to provide an effective analysis.

B. ANALYSIS OF TMSs WITHIN A SINGLE YEAR

The second level of analysis is to use information between TMSs in a single year. The approach here is to group together those TMSs which are in some sense similar or homogeneous with respect to their O&S cost structure. Cost data from among TMSs within the same group could then be combined and analyzed to develop standards for defining normal variability for similar TMSs.

Statistical methods for sorting like observations into groups are known as cluster analysis techniques. In cluster analysis generally little or nothing is known about the category structure. All that is available is a collection of observations whose category memberships are unknown. The basic objective is to sort the observations into groups such that the degree of association is high among members of the same group and low between members of different groups. A number of computer algorithms for producing clusters have been proposed and developed in the statistical literature. See, for example, Anderberg [3] and Hartigan [13].

At the level of analysis considered here, the clustering procedure can be based on two different sets of dependent variables. First, the clusters can be produced using the O&S costs in the various categories, C_{ijk}, as the dependent variables. Alternatively, the proportions of total O&S cost

corresponding to the various cost categories, P_{ijk}, can be used as the dependent variables. Both approaches should complement each other and provide greater insight when used together. In either case, the ultimate clustering of TMSs will be useful only if some sense can be made of the results. That is, the set of clusters may be viewed merely as a proposition concerning the organization of data. In order for this apparent organization to be meaningful, some practical interpretation must be given to the clusters. It should be emphasized that cluster analysis is an exploratory device. It cannot be expected that a given clustering procedure will always produce a set of clusters with direct practical relevance.

If a cluster analysis procedure is successful in that it produces meaningful groupings, it is important to realize that an anomalous TMS will probably not be sorted into a group where it naturally belongs. It is vital, then, that the analyst be aware of this consideration since outliers will adversely affect the clustering procedure and cloud the interpretation process. This suggests that cluster analysis may be useful as a direct means of data screening since it may help to expose those TMSs which are seemingly out of place with respect to their natural grouping.

It may be possible to supplement the clustering procedure by incorporating knowledge regarding a particular end item. For example, each C-E end item has a Federal Stock Class (FSC) classification which provides a general description of the end item. This information may be a direct aid to interpreting the set of clusters produced by a cluster analysis procedure. It may also provide a ready-made set of natural clusters useful for data screening purposes.

C. ANALYSIS OF TMSs ACROSS YEARS

The third level of analysis is to use information between TMSs across years. The key question at this level of analysis is whether it is reasonable to combine information from different TMSs. Of course, if it is not reasonable to combine TMSs, the level of analysis must then be reduced to an individual TMS basis, as previously discussed in subsection II.A.

To explore the feasibility of combining information from different TMSs, cluster analysis techniques can be applied to the O&S cost data. The clusters would initially be based on the first few years of data. Once the clusters are identified, multivariate statistical methods could then be used to determine whether a given TMS is anomalous relative to other TMSs also in its assigned group. Such procedures can be based on data either for only the year in question or for previous years also. The former would admit to a fairly straightforward analysis, while the latter would require more sophisticated procedures which accounted for year-to-year variation in the O&S cost data.

D. SYSTEM PROCESSING CONSIDERATIONS

Some information for monitoring C-E output data quality at the first analysis level is currently available directly from the output products, albeit at the aggregate levels of 1) total O&S cost and 2) total Logistics Support Cost (LSC). The Historical Cost Trend Report is designed to provide this information, as well as the rank and percentage change, for a ten-year period. In addition, the ranking reports detail various year-to-year comparisons in total O&S costs and LSC. However, efficient data quality

monitoring requires that less aggregated information (e.g., at the cost category level) be analyzed. The required information is readily accessible in the C-E system. Effecting such monitoring would require only straightforward expansion of current system processing. The programs involved are H3 (Build Health/PCS/Training and O&S Costs) and D1 (Build Demand Reports) in Work Unit XX.

There is currently no process in place for combining like TMSs as required for the second and third analysis levels. Thus, for any of the analysis levels, the inclusion of efficient automated monitoring of C-E output data quality would require substantial additions to current processing.

It should be noted that the C-E system is, for the most part, currently processing costs as intended. However, there are numerous improvements (many based on recommendations made by Desmatics) that should be incorporated into the C-E system. Some of these improvements require substantial processing revisions.

Until the C-E system becomes a stable production system, any year-to-year analyses of C-E cost allocations will have to consider processing changes that have occurred between fiscal years. Therefore, Desmatics recommends that the Office of VAMOSC postpone the development of procedures for automated monitoring of the C-E output data until such stability is realized. The following section, which focuses on the monitoring of inputs to the C-E system, discusses what can be accomplished in the interim.

III. MONITORING C-E INPUT DATA

Development of data quality parameters must begin with the inputs to the system under consideration. There are two types of inputs to C-E system processing. The first is a set of four tables maintained by the Office of VAMOSC: the TMS-NSN, PAS-ORG, Unit Factor, and OAC/OBAN Tables. The second type is data provided through interfaces with nine Air Force data systems. The Data System Designators (DSDs) and titles of these systems are as follows:

DSD	Title
D039	Equipment Item Requirements Computation System
D041A	Recoverable Consumption Item Requirements Variable Safety Level System
E300Z	Advanced Personnel Data System
0013	Packaging and Transportation Data Maintenance System
D056A	Product Performance System
H069R	Accounting and Budget Distribution System
D002A	*Standard Base Supply System*
H036B	Depot Maintenance Industrial Fund Cost Accounting and Production Report System
C003K	AFCC Engineering/Installation Management System

In this section, each input is examined with regard to monitoring abnormal variability of data. Data monitoring is currently feasible and appropriate only for some of these inputs. Methods for monitoring such inputs, which can be incorporated into the C-E system as currently processed, have been provided. The problems associated with attempting to monitor the remaining inputs at this time are also discussed.

A. TABLES

Work Unit IA is designed to provide a means for the Office of VAMOSC to

determine the information needed to update the four C-E tables (TMS-NSN, PAS-ORG, Unit Factor, and OAC/OBAN). The TMS-NSN Table contains a list of equipment to be costed. The PAS-ORG Table contains a list of the owning organizations which have been subjectively determined to have a balanced mix of this equipment and C-E personnel. These two tables are the principal drivers of the C-E system.

Work Unit IA is currently run after the fourth quarter D039 Format 100 data is received. Updates to the tables are determined in this work unit, and actually processed in Work Unit AR. All additions, deletions, and revisions to tables are keypunched manually. Work Unit IA is functioning as intended, but documentation is inadequate with regard to the interrelationships between the reports generated and the ultimate handling of these reports. Timing considerations are not as yet documented, and there are instances in which updates to a table depend on prior updates to another table.

1. TMS-NSN Table

The TMS-NSN Table contains the list of end items which are costed. Each record in this table contains the following information: TMS designator, National Stock Number (NSN), Standard Reporting Designator (SRD), Air Force Specialty Code (AFSC) of Base Maintenance personnel assigned to the SRD, Preventative Maintenance and Inspection (PMI) hours, and KWH usage. According to the Office of VAMOSC, PMI hours will be obtained from D056A beginning with FY86 processing, and Electric Utilities will be dropped as a category beginning in FY87. Following these changes, PMI hours and KWH usage will no

longer be required on the TMS-NSN table.

Currently there is no process, either formal or informal, for adding TMSs to the C-E system. Deletions are determined by nonmatches between National Item Identification Numbers (NIINs) on the TMS-NSN Table and D039 Format 100 data, in the first step in Work Unit IA (Program I1). All TMSs so flagged should be deleted from the TMS-NSN Table, except those with a NSN composed of all nines, which represent TMSs with duplicate NSNs with multiple SRDs.

Equipment items from the D039 system are selected by NIIN, and thus are dependent upon valid TMS-NIIN relationships on the TMS-NSN Table. These relationships are established in the Joint Electronic Type Designator System (JETDS) [16]. Should an invalid TMS-NIIN relationship exist on the TMS-NSN Table, it would likely remain undetected if the NIIN itself was valid, since the TMS-NSN Table is the only point in the C-E system where the TMS-NIIN relationship is documented. However, all costs developed for the TMS using the NIIN would be incorrect, and mismatched with those developed using SRDs.

There is presently no system in place to validate TMS-AFSC relationships on the TMS-NSN Table. Desmatics recommends that such a system be implemented, because AFSCs are known to change over time. Some erroneous AFSCs were found in the FY84 C-E TMS-NSN Table [12]. If a TMS-AFSC relationship in the TMS-NSN Table is invalid, base labor manhours from the D056A system cannot be matched to that TMS. Costs for Base Maintenance Personnel, and the Permanent Change of Station (PCS) and Medical (MED) costs for these personnel, will be unallocated or misallocated as a result.

The C-E system uses SRDs to identify data from D056A, C003K, and D002A. If a TMS-SRD relationship in the TMS-NSN Table is invalid, costs for Base Maintenance personnel, Mobile Depot Maintenance (MDM), and Maintenance

Material will be lost or misallocated. TMS-SRD relationships, which are established using TO 00-20-2 and the Electronic Security Command equipment list [16], should be reconciled with updated versions of these documents on an annual basis.

For FY86 processing, the TMS-NSN Table should be updated to insure that the first entry for a TMS with multiple SRDs contains the appropriate PMI hours; this is the entry used to process Base Maintenance Personnel costs. Until Electric Utilities is eliminated as a cost category, the TMS-NSN Table should be updated to insure that TMSs with multiple records have identical KWH consumption values for each entry, and that TMSs with KWH reported as 99999 be updated to their true value.

2. PAS-ORG Table

The PAS-ORG Table consists of a list of organizations which are subjectively determined to have a balanced mix of C-E equipment and C-E personnel and a C-E-related mission. Every cost category should be based on the organizations in the PAS-ORG Table. However, the following six categories are not [11]:

Base Maintenance Personnel
Maintenance Material
Engineering Support
Depot Maintenance
Replacement Investment
Transportation & Packaging (T&P)

The PAS-ORG Table contains the following information: Personnel Accounting Symbol (PAS), Organization Code (which includes organization

number, abbreviated name, type, and detachment number) [20], Geographic Location (GELOC), and Real Property Maintenance (RPM) Factor. The GELOC and RPM Factor are no longer used in C-E processing.

Updates to the PAS-ORG Table are determined in the second step of Work Unit IA (Program I3). Matches between the TMS-NSN Table and D039 Format 100 data are screened against the PAS-ORG Table. Reports entitled PAS-ORG Table Additions, PAS-ORG Table Deletions, and the TMS-PAS List (which contains matches) are generated.

In the next step of Work Unit IA (Program I5), personnel counts from the C-E Military Personnel Center (MPC) Extract Personnel File are summed by PAS for Functional Account Codes (FACs) 26XX, 34XX, 35XX, and 38XX, and matched by PAS against the TMS-PAS List. Matching PASs are output as the TMS-MPC List. Some of these PASs will be rejected in later C-E processing, however, because the selection of FACs does not represent the personnel selection criteria used in C-E processing. Nonmatching PASs are output to one of two files: the "Invalid PAS" list for those PASs not present in the C-E MPC Extract, and "C-E Personnel Without C-E Equipment" for those PASs not present in the TMS-PAS List. Those PASs on the "Invalid PAS" list should be deleted from the PAS-ORG Table, and those PASs on the "C-E Personnel Without C-E Equipment" list are candidates for addition if present on the PAS-ORG Table Additions report generated in Program I3.

The definition of a C-E organization is somewhat arbitrary; the mix of personnel and equipment is examined subjectively, and considered in conjunction with the type of TMSs the organization owns and the organization's mission. For additions to the PAS-ORG Table, the PAS corresponding to the Organization Code in the Additions list is obtained from the PAS Directory

[20], which is updated monthly by AFMPC. It is critical that the correct PAS from the directory be assigned on the basis of organization number, type and detachment number, and that no AF Guard and Reserve organizations be included because the C-E system is designed to exclude such units. Costs for three categories of Unit Mission Personnel (Operations, Administrative, and Supply Support) are developed by PAS and allocated to TMSs at this level. An invalid PAS-Organization Code relationship on the PAS-ORG Table results in misallocation of these costs. Desmatics recommends an annual check of all PAS-Organization Code additions, because an error of this nature would remain undetected as long as both the PAS and Organization Code were valid.

There is currently no process for handling organizations which are candidates for addition to the PAS-ORG Table but which are not in the PAS Directory. Such situations must be investigated individually by the C-E Action Officer.

Currently the criteria for removal of an organization from the PAS-ORG Table are either the lack of any C-E TMSs or lack of any C-E personnel. Reductions of C-E personnel and equipment assigned to a C-E organization from year to year are not considered. Under the current criteria for updating the PAS-ORG Table, a PAS would never be flagged for deletion as long as it owns at least one C-E TMS and is assigned at least one C-E person.

A substantial revision of Work Unit IA is required in order to collect all the data necessary at one point to properly update the PAS-ORG Table. First, Desmatics recommends that PAS-ORG Table additions and deletions be made according to the reports generated from the D039 Format 100 match in Program I3. This should be accomplished before Program I5 processing is begun. All PASs flagged for deletion should be removed from the table, and additions must

be considered individually by the C-E Action Officer according to number and type of TMSs owned. The updated PAS-ORG (Workfile) Table will contain all PASs which own C-E equipment, regardless of personnel strengths.

Secondly, Program I5 should be revised to provide the following: a report with the sum of personnel in the C-E MPC Extract Personnel File by category (Operations, Supply Support, Administrative, and Base Maintenance), according to C-E personnel selection criteria, for each PAS in the PAS-ORG (Workfile) Table. The following sample format contains a subset of FY84 data:

	C-E PERSONNEL				
PAS	OPS	SSUP	ADM	MAINT	TOTAL
AFOUF4RY	31	0	0	1	32
AFOYFFJO	119	3	32	61	215
AHOUFX1R	519	2	7	62	590
AHOUF32H	3	0	0	4	7
AHOYFFFZ	55	0	6	16	77
AHOYFFRO	13	1	2	14	30
AHOYFFR4	97	3	15	51	166
AMOYFFNR	99	2	12	40	153
ATOSFYCZ	1	0	2	0	3
ATOYFFMK	100	1	32	62	195
AUOYFFJ1	275	5	56	177	513

The number and type of personnel assigned to each PAS which owns C-E equipment would then be visible in one report. The PASs on this list should be considered in conjunction with the TMS-MPC list produced by Program I3, and the C-E Action Officer should be responsible for the final determination of which PASs to include on the final PAS-ORG Table. For example, in the above list the mix of C-E personnel strengths for PASs AHOUF32H and ATOSFYCZ indicates that they should be examined as candidates for deletion. The complete list of such PASs in the FY84 data is contained in Desmatics' Technical Report No. 118-11 [12].

3. Unit Factor Table

The Unit Factor Table, is designed to contain the Reporting OAC/OBAN for each organization on the PAS-ORG Table. This table has the following fields: PAS, Reporting Operating Agency Code/Operating Budget Account Number (OAC/OBAN), four Responsibility Center/Cost Center (RC/CC) Codes, and Base Communications Factor. The fields containing RC/CCs and the Base Communications Factor are no longer used in C-E system processing.

The PAS-OAC/OBAN relationship is utilized only for the processing of TDY costs in the C-E system. The Unit Factor Table is used to select organizations from the Personnel Data File for which personnel counts are summarized and for which the following costs are computed: Operations, Administrative, and Supply Support Personnel, associated Medical and PCS costs for these personnel, and Electric Utilities.

All PAS-OAC/OBAN relationships must be updated annually based on information received from inquiries sent to each MAJCOM. It is essential that this data be obtained for the appropriate FY and for all PASs on the updated PAS-ORG Table. Updates for the PAS field in the Unit Factor Table are determined in Program I6 of Work Unit IA, in which the current Unit Factor Table and the TMS-MPC List are matched by PAS. On matches, the OAC/OBAN from the Unit Factor Table is appended to each appropriate record on the TMS-MPC List. Reports entitled Unit Factor Table Additions and Unit Factor Table Deletions are generated.

4. OAC/OBAN Table

The OAC/OBAN Table is a separate table consisting of all OAC/OBANs present on the (updated) Unit Factor Table. This table contains the fields of Reporting OAC/OBAN, Supporting OAC/OBAN, and RC/CC. The Supporting OAC/OBAN and RC/CC fields are no longer used in C-E system processing. The OAC/OBAN Table is updated in Program I7, and is the last table to be updated in Work Unit IA. The Unit Factor Table is matched by OAC/OBAN to the existing OAC/OBAN Table, and reports of recommended additions and deletions are generated.

The OAC/OBAN Table presently is only used to extract Temporary Duty (TDY) costs, which are selected by OAC/OBAN and Element of Expense/Investment Code (EEIC), from the C-E Accounting System for Operations (ASO) Extract File. TDY costs are then allocated to PASs with the PAS Allocation Factor, and then to TMSs with the Unit TMS Allocation Factor. Unnecessary OAC/OBANs on this table cause extra processing in the C-E system, but do not result in misallocation of costs. TDY costs are lost for OAC/OBANs not present on the table.

The PAS Allocation Factor, which relates the total number of personnel at a PAS to the total number of personnel at all PASs with the same Reporting OAC/OBAN, is currently computed only for those organizations on the PAS-ORG Table. In order to compute this factor correctly, all PASs associated with a given Reporting OAC/OBAN should be included in the denominator of this factor. This requires substantial program modification, and possibly the addition of a new table to the system with Reporting OAC/OBANs and all associated PASs, not only C-E PASs. It would also be necessary for the Office of VAMOSC to obtain for each OAC/OBAN the list of all additional PASs which report under the

OAC/OBANs of interest.

Although TDY is the only cost category presently affected by the OAC/OBAN Table, Desmatics has recommended [23] that the Office of VAMOSC utilize these OAC/OBANs for the initial selection of H069R data. This would result in a more complete selection of unit level costs than the current method, which is to select only RC/CCs of xx26xx, xx35xx, and xx38xx in VAMOH, the VAMOSC preprocessing system.

In order to monitor the OAC/OBAN Table for completeness under current processing, a list containing H069R costs for OAC/OBANs on the Table could be generated in Program EE in VAMOH preprocessing (which produces the C-E ASO Extract File). If such a list were generated, OAC/OBANs on the table with no H069R costs could be investigated as potential invalid OAC/OBANs on the OAC/OBAN Table.

5. Summary

Work Unit IA, with expanded documentation and some revision, could provide the Office of VAMOSC with the information necessary to properly update C-E tables. Because Work Unit IA involves a large amount of manual input, an exact and orderly fashion of implementing this work unit should be included in the C-E System Specifications.

The information contained on both the Unit Factor Table (PAS and Reporting OAC/OBAN) and the OAC/OBAN Table (Reporting OAC/OBAN) could be incorporated into the PAS-ORG Table. There is no logical reason for these tables to exist separately. The combination of these tables would necessitate programming changes in Programs E1 and F2 in Work Unit YY. Combining these

tables would simplify the task of monitoring the data necessary to update them.

As stated previously, Desmatics recommends that additions and deletions to the PAS-ORG Table be made immediately after Program I3. The PAS-ORG (Workfile) Table should be updated and used in subsequent processing in Work Unit IA. Program I5 should be modified to select and classify MPC data according to the C-E personnel selection criteria, and not just certain FACs. The creation of a properly updated PAS-ORG Table for use in Work Unit YY is not possible until this is accomplished.

It is advisable for the PAS-ORG Table to be updated each year prior to the request for appropriate PAS-OAC/OBAN relationships from each major command (MAJCOM). It is imperative that data for the correct FY be requested of each MAJCOM. If this is not done, then the list of PASs for which OAC/OBANs are requested may be incomplete. These inquiries are mailed in August [lo], yet Work Unit IA is not currently begun until the fourth quarter D039 Format 100 data is received, which would be sometime after September. The timing of this request relative to the timing for C-E processing indicates that a follow-up request for additional OAC/OBANs may be necessary.

B. D039

Two files, the Format 50 and the Format 100 Files, are obtained annually from the D039 system. The Format 50 File provides worldwide quarterly inventory figures and Acquisition Costs. The Format 100 File, which is a fourth quarter file, provides organizational inventories of C-E equipment. Actual data elements in this latter file are Stock Record Account Number

(SRAN), Organization Code, NSN and Quantity on Hand (QOH). The SRAN is no longer used in C-E system processing.

Quarterly inventory figures from the Format 50 File are used to compute the average annual inventories of C-E end items; these are used in the computation of two allocation factors. These factors, and the cost categories in which they are used, are as follows:

Factor	Cost Categories
Recoverable Allocation Factor (RAF)	Depot Maintenance Replacement Investment T&P
Base Labor Allocation Factor	Base Maintenance Personnel PCS (Base Maintenance Personnel only) Medical (Base Maintenance Personnel only)

Additional information on the RAF and the Base Labor Allocation Factor can be found in the Appendix to this report.

Acquisition Cost is used in the computation of two allocation factors. These factors, and the cost categories in which they are used, are:

Factor	Cost Categories
Unit TMS Allocation Factor	Administrative Personnel Supply Support Personnel Base Operating Support (BOS) RPM Communications (COM) PCS TDY Medical
Worldwide TMS Allocation Factor	General Depot Support (GDS)

The Unit and the Worldwide TMS Allocation Factors are discussed in the Appendix of this report. Organizational level inventories (QOH) from the D039

Format 100 File are also used in the computation of these two factors. In addition, QOH is used in developing Operator Factors for allocating the direct and indirect costs of Operations Personnel, and in the computation of Electric Utilities costs.

It should be noted that the effectiveness of the following suggested monitoring of D039 costs and inventories is currently affected by two conditions: (1) The D039 Files used in the C-E system are presently limited to C-E FSCs [15], (2) The Unit and Worldwide TMS Allocation Factors are processed only for the inventory of C-E TMSs owned by C-E organizations. These conditions cause an understatement of the denominators of the above factors and overallocation of costs developed with them. More complete development of these factors requires data for all items in the inventory of organizations in the PAS-ORG Table. Complete monitoring of Acquisition Costs requires identification of all NIINs in the Format 50 File to a TMS designator.

The end item Acquisition Costs on the D039 Format 50 File should be monitored in order to check items with reported Acquisition Costs that are abnormally high or abnormally low. During Desmatics' study of FY84 Data [12], the TMSs with the ten highest and ten lowest reported Acquisition Costs were extracted for study. Two TMSs, GRA006 and GSC037, had a reported cost of zero. One TMS, UYQ014V had a reported cost of one dollar, and another, TSC062, had a reported cost in excess of 100 million dollars. These four records were obviously anomalous.

There were 62 TMSs on the FY84 C-E Inventory File with multiple NIINs with different Acquisition Costs. Small variations in cost can be expected for items from different manufacturers or for different acquisition dates.

However, some TMSs had questionable differences in reported Acquisition Costs for their different NIINs. Desmatics tested a yearly monitoring procedure by extracting records from the C-E Inventory file for TMSs with multiple NIINs if they met either of the following two criteria:

(1) The lowest reported Acquisition Cost was less than 25% of the highest reported Acquisition Cost.

or (2) The lowest reported Acquisition Cost was over $100,000 less than the highest reported Acquisition Cost.

The TMSs which qualified, along with their NIINs and reported Acquisiton Costs, are in Table 1.

There are at least three TMSs in Table 1 which appear to exhibit genuine anomalies. These are: FRC165V with two NIINs whose acquisition costs differ by a factor of 10, TSC062 with two NIINs whose costs differ by over 109 million dollars, and UYQ14V with one NIIN costing over $370,000 and one costing only one dollar.

In its studies of FY83 and FY84 data, [11,12], Desmatics observed apparently anomalous discrepancies in reported quarterly inventories in the D039 Format 50 File. These discrepancies can be viewed as outliers in the quarterly inventories. A great deal of research has been conducted on the problem of outliers in data. Barnett and Lewis [10] summarize a variety of test statistics for use in identifying outliers.

Although any of these statistics could be used to develop a decision rule for classifying an observation as an outlier, the particular one Desmatics recommends has received the most attention in the data analysis technical literature. This rule is to classify observation x_i as an outlier if:

TMS	NIIN	COST
CV0425U	002633326	145
CV0425U	009859088	1000
FCC032V	008944629	21800
FCC032V	009136555	125000
FPS077V	001189661	2000
FPS077V	009795393	2573
FPS077V	001300781	4000
FPS077V	001189660	10000
FPS077V	008748532	24486
FRC165V	010282691	36000
FRC165V	010282692	360000
FTA015	007547487	2000
FTA015	009881008	2370
FTA015	000663808	3175
FTA015	008565978	12800
GKC001	010346203	5760000
GKC001	010346199	9675000
GKC001	010346197	11250000
GKC001	010346198	11250000
GMD002	007531862	29966
GMD002	009820021	128581
GMQ010B	006704846	438
GMQ010B	006704849	1159
GMQ010B	006704848	1494
GMQ010B	006704847	2045
GMQ010B	006704850	2163
GMQ010B	006510470	7299
GMQ013A	005575838	3740
GMQ013A	005812000	5834
GMQ013A	005575839	8831
GMQ013A	005514830	18405
GRR024	001233945	612
GRR024	010346087	2497
GRR024	010226392	2566
GRR024	010288035	2566
GRR024	010362760	3280
ID1631A	009371486	200
ID1631A	001791854	850
M028ASR	008670275	409
M028ASR	000453872	2163
M028ASR	001085505	2250
M028ASR	000210763	3040
M028ASR	000210748	12020
TMQ011V	006082646	749
TMQ011V	000508140	1854
TMQ011V	006082643	1996
TMQ011V	005815591	2996
TMQ015	002235098	688
TMQ015	009916342	2909
TSC062	004437414	553625
TSC062	010662443	110330000
TSC60V1	000097970	293752
TSC60V1	001979925	673413
TSC60V2	001529423	326871
TSC60V2	001979927	880898
TTC030	002422757	50000
TTC030	001998746	481500
UYQ014V	010036579	1
UYQ014V	010036578	371121
302	008639649	2668
302	008639651	8525
302	008639650	9189
302	007399615	12850

Table 1: TMSs with Multiple NIINs with Apparently Anomalous, Inconsistent Acquisition Costs.

$$|x_i - \bar{x}| > Ks$$

where x_i = the reported inventory for the ith quarter,

$\bar{x}$ = the sample mean of the reported quarterly inventories,

$|x_i - x|$ = the absolute value of the difference $x_i - x$,

K = a value to be selected by the Office of VAMOSC,

and s = the sample standard deviation of the reported quarterly inventories.

This statistical rule for identifying outliers will work well except in the instance where two of the four quarterly inventories are anomalous. Although this is unlikely, it does, in fact, occur in the FY84 C-E data for the GRR023, where the quarterly inventories are 30166, 166, 30168, and 159, respectively. To detect such occurrences, the above decision rule can also be applied to the inventories from the first three quarters only.

Based on this rule, records identified as anomalous can be extracted from the D039 Format 50 File for study and possible update. The number of records extracted for study will be inversely related to the value of K. It should be noted that the optimal value for K when this test is applied to four quarters of data will not be the optimal value when applied to three quarters of data. Selection of the optimal value of K for these two cases will require decisions on the part of the Office of VAMOSC before such monitoring is implemented.

An additional inventory discrepancy uncovered during the investigation of FY84 data, which must be monitored, is the inconsistency between fourth quarter Format 50 inventories and summed Format 100 inventories. This includes cases in which the Format 50 quarterly inventories are all zero, yet the Format 100 File indicates that end items are on hand at one or more

organizations. These inconsistencies should be examined individually and adjusted if necessary by the C-E Action Officer before any costs are processed with this data.

To monitor acquisition costs and inventories, Desmatics suggests adding a validation program in Work Unit YY to run just prior to Program Y2 (Build Inventory Data Base). This program must include the following steps:

1. Extract a set of records from the sorted D039 Format 50 File (PJIA8A0) with the highest and lowest reported acquisition costs. These records need to be reviewed and updated if necessary.

2. Match the sorted TMS-NSN Table (PJIY1A0) to the sorted Format 50 File (PJIA8A0) and append the TMS designator to the matching Format 50 records. Extract records for TMSs with multiple NIINs with differing acquisition costs and review for inconsistencies. To select only the worst discrepancies, extract records only for those TMSs with a lowest reported Acquisition Cost which is either less than some chosen percentage of the highest reported Acquisition Cost, or which is greater than some specified dollar value less than the highest reported Acquisition Cost. (Desmatics used 25% and $100,000, respectively, to test the FY84 data.) Update these records if necessary.

3. For each record in the sorted D039 Format 50 File (PJIA8A0), compute the sample mean and sample standard deviation for all four quarters of data and for any three other quarters. Extract records for study

and possible update if the absolute value of the quantity produced by subtracting the sample mean from any of the reported inventories, is greater than the quantity produced by multiplying the sample standard deviation by a constant (to be determined by the Office of VAMOSC).

4. Using the sorted Format 100 File (PJIA4AO) sum QOH over NIIN to produce a temporary file. Match this file to the sorted Format 50 File by NIIN, and append the Format 100 inventories to these records. Extract all records in which the fourth quarter Format 50 inventory is inconsistent with the Format 100 summed inventory. Update records with obvious anomalies.

C. D041A

Four files, denoted as Formats 1, 5, 8 and 50, are received annually from the D041A system. The data elements provided in these formats are as follows:

Format	Data Elements
50	Application NSN Recoverable NSN Program Begin Date Quantity Per Application (QPA) Application Percentage
1	Recoverable NSN Unit Cost
5	Recoverable NSN Base Condemnations
8	Recoverable NSN Depot Condemnations

By iteratively matching Format 50 File application NIINs to recoverable NIINs, components of end items are mapped through three levels of indenture. Recoverables on this D041 file are master recoverables. These components are the most preferred of any number of substitutable or interchangeable parts for a given application. Lack of data for the substitutable or interchangeable components results in understatement of costs for end items when these components are actually used in depot maintenance actions reported in H036B. In addition, documentation regarding operational requirements for the D041 system [19] implies that the relationship between the master item and interchangeable recoverables for any given application is relatively dynamic. If all records for the lower level components of a new master recoverable are not entered into the D041 system, these components cannot be identified to their associated end items in the C-E system.

During Desmatics' study of the FY84 C-E production run, the mapping of recoverables to end items and computation of associated RAF numerators were replicated. Approximately 92% of all recoverables identified in this process were at the first level of indenture. This finding may or may not be significant. It is possible that the vast majority of all recoverables are first level components. If this is not the case, this finding indicates that the D041A data used in the C-E system is inadequate for complete identification of recoverables to end items. This would explain the low percentage of recoverables selected at levels below the first. A thorough study of the D041A system needs to be conducted before this finding can be properly evaluated for monitoring purposes.

The Program Begin Date on the Format 50 records is used to select the most recently created record among duplicates for a given NIIN. The purpose

is to select the record with the most current QPA and Application Percentage. Desmatics lacked the proper documentation on Program Begin Dates to evaluate this procedure.

The QPA and Application Percentages are used in the calculation of RAFs. Zero QPAs or Application Percentages will result in RAFs of zero. During Desmatics' mapping of recoverables to end items, D041A Format 50 records with zero QPAs and/or Application Percentages were selected. Zero QPAs or Application Percentages would seem to be anomalous. Desmatics has learned, however, that Application Percentages may be zero for a recoverable during the time lag between its substitution with another recoverable and its removal from the D041A data base. No explanation has yet been provided on why QPAs might be reported as zero, especially when the corresponding Application Percentage is nonzero.

Desmatics recommends that D041A Format 50 records with zero QPAs or Application Percentages be extracted in Work Unit YY, prior to Program Y4, annually. If a zero is legitimate, the record should be removed. If it is not, the record should be updated to reflect the actual QPA and Application Percentage. The C-E Action Officer can obtain this information from item managers.

Three more D041A data elements are required in order to allocate recoverable level Replacement Investment and T&P costs to end items: Unit Cost, Base Condemnations and Depot Condemnations. These three data elements are obtained from the Formats 1, 5 and 8 files respectively. If any of these elements for a particular recoverable is incorrect, all end item applications of the recoverable will have inaccurate Replacement Investment and/or T&P costs.

According to D041A system documentation [19] reported base and depot condemnations are either forecasted or actual, depending on input data processed by the D041 system. Without further investigation into the processing and reporting of condemnation information in the D041A system, Desmatics believes that it is impossible to devise a proper monitoring procedure for this condemnation data.

One D041A data element that should be monitored is the unit cost of components. During Desmatics' study of FY84 data, Table 3-4 was found to have five recoverables with reported unit costs of zero. However, it was not possible to determine whether this was due to D041A Format 1 data or the way missing Format 1 records are handled in the C-E system. The recoverables with zero unit costs are as follows:

TMS	Recoverable NIIN
FYQ005	009774378
GRA006	006444554
GSC037	010556235
GTC028	010222660
GTC028	010433362

These particular records did not cause any underallocation of Replacement Investment costs because none of these recoverables had any reported base or depot condemnations. However, Desmatics suggests that Format 1 records with zero costs be extracted in Work Unit YY, prior to Program YA. The C-E Action Officer can then update these records before processing begins.

Ideally, unit costs in the D041 data should also be monitored for nonzero values that are incorrect. This monitoring would be limited to detecting abnormally high or low values. In Desmatics' opinion, a thorough study of this data system and its record maintenance procedures is required before this

problem can be addressed adequately.

D. E300Z

Quarterly data from the E300Z system is preprocessed in VAMOH. Records for FACs 26XX, 34XX, 35XX, and 38XX are selected, and PCS costs for military personnel with a reported Date-Arrived-on-Station within the previous FY are computed and appended to these records. The resulting annual file from the VAMOH system is called the C-E MPC Extract Personnel File; it contains the following data elements:

GELOC
MAJCOM
Program Element Code (PEC)
PAS
Organization Code
FAC
AFSC
Flying Status Code
Grade
Number of Personnel by Grade
PCS Cost
Number of Personnel Air Force-wide

Information from this file is used in the development of ten cost categories. These are:

Operations Personnel
Base Maintenance Personnel
Administrative Personnel
Supply Support Personnel
BOS
RPM
COM
TDY
Medical
PCS

One data element in the C-E MPC Extract Personnel File which needs to be monitored in the C-E system is the AFSC. The three possible changes in AFSCs,

all of which can affect the processing of costs are 1) creation of a new AFSC, 2) the deletion of an AFSC or 3) the consolidation of two or more AFSCs. Changes in AFSCs are documented regularly in AFR 36-1 [18] and AFR 39-1 [2].

Changes in AFSCs need to be monitored by the C-E Action Officer on an annual basis. The effect of any such changes on the C-E personnel selection criteria and the list of Base Maintenance personnel AFSCs in the TMS-NSN Table must then be assessed. Where indicated, updates to AFSCs must be incorporated into the C-E system before annual processing begins. The updates to the TMS-NSN Table are done in Work Unit IA. The personnel selection criteria are part of Program B3 in Work Unit YY.

E. 0013

Item packaged weights by NSN are obtained from the 0013 Packaging and Transportation Data Maintenance System. Monthly data from this system is preprocessed and summarized quarterly in the VAMOH system. A fourth quarter summmary file with data from SM-ALC, WR-ALC, and SA-ALC is submitted to the C-E system. Packaged weights from this file are used to compute one-way and round trip T&P costs in the C-E system.

The weight field on the 0013 data file is currently limited to six positions with a decimal between the fourth and fifth positions. In the 0013 system weights in excess of 9999.99 are either reported as this, or the letters "REV" are inserted to flag them for review. The letters "REV" are also inserted for other unavailable weights [21]. A listing of these records is provided to the Office of VAMOSC for review. If these records are not then updated by the Office of VAMOSC, they appear unchanged in Table 5.

In its study of FY83 and FY84 C-E data, Desmatics found Table 5 records with these two types of entries, i.e., reported weights of "REV" or 9999.99. In addition, there was a considerable number of zeros, indicating the absence of records in the 0013 file for the associated items. Furthermore, packaged weights in FY84 differed from those in FY83 for some items [12]. It is not clear why such changes should occur.

To monitor the 0013 weight data, the Updated Packaged Weight File (PIIVDAA) can be matched on NIIN with the Recoverable Cost File (PJMYBAO), which is generated in Program YB in Work Unit YY. Nonmatching NIINs from the Recoverable Cost File can be extracted for manual input of correct packaged weight data. Matching NIINs with weights of 9999.99 or "REV" should also be extracted and updated.

An alternative is to establish a weight table for all end item and recoverable NIINs in the C-E system, and update this table annually. The initial version of this table can be generated with the procedure described in the paragraph above. In subsequent years, the 0013 file from the VAMOH preprocessor system should be matched to the existing table and the Recoverable Data Base File to generate the following three lists for use in updating the table:

1. Records from all three sources with nonmatching weights in the existing table and 0013 file.
2. Matching records from the Recoverable Data Base and 0013 file with no matching record on the existing table.
3. Records from the Recoverable Data Base not in the 0013 file or the existing table.

All of these records need to be updated and added to the existing table. The updated version of the table should be used as an input to Program XA (Build

Table 5) in Work Unit XX. It should be noted that this table would have to be matched tc current D041 data periodically in order to delete obsolete records.

F. OTHER INPUTS

There are various problems which largely preclude the establishment of data quality parameters for a number of C-E system inputs at this time. The data systems involved are: D056A, H069R, D002A, H036B, and C003K. For this data, normal variability is currently indeterminate for monitoring purposes. In this section the problems associated with each of these interfaces are examined.

1. D056A

Data from the D056A system is received monthly and preprocessed in the VAMOH system to produce an annual file, the Cumulative C-E Base Labor Summary File. This file contains corrective and PMI labor hours identified to the SRD level. These labor hours are used to develop Base Labor Allocation Factors for allocating Base Maintenance Personnel costs and Medical and PCS costs for these personnel.

Maintenance labor hours for some end items are not reported to the D056A system. In addition, there are organizations which are not required to report labor hours to this system for some or all of their item inventory. These two types of reporting exemptions are documented in TO-20-02 [14]. As discussed in an earlier report [11], allowances could be made in the C-E system processing for these documented exemptions. Both Desmatics and the Office of

VAMOSC are also aware that reporting to the D056A system is optional for certain AFCC organizations. Desmatics has been unable to determine whether it is possible to obtain accurate information on the level of maintenance manhour reporting for these organizations. Without such information, the level of inventory represented by the reported hours in D056A is currently indeterminate for many end items.

Until all reporting exemptions for the D056A system can be completely documented, C-E system processing using this data cannot be revised to provide reliable estimates of costs for Base Maintenance personnel. In addition, effective monitoring procedures cannot be established until such documentation is available.

2. H069R

Cost data from H069R is used for the following C-E O&S categories: TDY, GDS, BOS, COM, and RPM. Input data aggregated to the command level is obtained annually from each of eleven MAJCOMs. This input data is monitored in several ways in the VAMOH preprocessing system [17]. Records are dropped if the dollar field is zero. Because the field size is excessively large in the input data for cost (14 characters), records are flagged for research if a character appears in any of the three highest positions. Balance Indicators are checked to identify reimbursements; the sign on these reimbursements is changed since they need to be subtracted from their corresponding expenditures. The data from the various MAJCOMs is combined, and a file of costs relevant to the C-E system, the C-E ASO Extract File, is generated. The data elements on this file are OAC/OBAN, PEC, RC/CC, EEIC, and cost.

Desmatics has previously recommended changes to the H069R data selection criteria for developing costs in the C-E system [23]. Until these criteria have been established and validated, and the recommended changes to the affected algorithms made and also validated, it would not be helpful to establish any further monitoring procedures for this data beyond what is now done in the VAMOH preprocessor system.

3. D002A

Monthly maintenance material costs are obtained from the Standard Base Supply System (SBSS), D002A, and preprocessed in VAMOH to produce an annual file for the C-E system. This file, the Cumulative C-E Base Material File, contains (base) supply consumable and Time Compliance Technical Order (TCTO) Kit material costs by SRD.

Very little of the data of interest to the C-E system is extracted under the current selection logic in the interface with the D002A system [5]. Therefore, this input data cannot be effectively monitored at this time.

4. H036B

The H036B (Depot Maintenance Industrial Fund Cost Accounting and Production Report) system is the source of depot-level maintenance (program) costs and production quantities for C-E end items and their recoverables. Costs are reported in H036B for twenty-four separate cost elements; twenty-one of these currently are included in the Depot Maintenance cost allocation algorithm. Production quantities are used in the development of T&P costs.

Reported zeros for program costs or production quantities in Table 3-4 indicate an absence of records for that item in the H036B input file. The considerable number of zeros found in the FY84 C-E Table 3-4 for these data elements [12] is apparently due primarily to the unavailability of cost data for items assigned to AFCSC for depot level repair, and to incomplete information in the D041A system files used to identify and relate recoverables to end items. In Desmatics opinion, it would not, therefore, be helpful to attempt to establish any procedures for monitoring input from the H036B system at this time.

5. C003K

Costs for labor, material, and TDY expenses incurred by AFCC Engineering and Installation (E&I) Teams are obtained from C003K by SRD. The file received generally has approximately thirty records. The ownership of the equipment for which costs are reported should be verified, since it should at this time conform to that for the H036B data used for the remaining depot-level costs. Because of its relatively small size, this file should be examined manually for possible anomalies.

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APPENDIX

Costs for C-E equipment are not available directly at the end item level. Therefore, costs for all C-E O&S categories are developed with allocation algorithms appropriate, in each case, to the data inputs used. These algorithms are documented in the 1982 C-E User's Manual [24]. However, some of the C-E cost allocation algorithms have been changed substantially since 1982, and this manual is currently under revision. This appendix has been included to provide the updated versions of the algorithms now used to process costs in the C-E system, and which were in effect for the study of FY83 and FY84 C-E data recently completed by Desmatics [11,12].

In this appendix, the allocation algorithms for all except three of the individual categories on the C-E O&S Cost Report are described. The exceptions are Fuel, Engineering Support, and Advanced Training. There currently are no algorithms for computing Fuel and Advanced Training costs. Engineering Support costs are obtained from Sacramento Air Logistics Center (SM-ALC) already allocated to all end items within the equipment system to which the costs apply.

The description of the proposed algorithm for Operations Personnel costs, which are not currently processed because the requisite input data is still incomplete, has been included for informational purposes only. The remaining algorithm descriptions reflect the status of the C-E system just prior to the processing of FY86 data. Any previously recommended or proposed changes not implemented by that time have not been addressed.

A. UNIT MISSION PERSONNEL

C-E Unit Mission Personnel are currently grouped into four categories: Operations, Base Maintenance, Administrative and Supply Support. The four categories of C-E Unit Mission Personnel are identified by Functional Account Code (FAC), Air Force Specialty Code (AFSC) or FAC/AFSC combinations. The first step in the development of costs for these personnel involves obtaining counts by grade for each category in each C-E unit or organization. Each of these counts is multiplied by the standard composite pay rate for that particular grade of personnel [22]. The algorithms for allocating these costs to TMSs are discussed in the subsections below.

1. Operations Personnel

Operations Personnel cost is the allocated cost of pay and allowances for personnel required to operate a given C-E end item at all owning organizations in the Personnel Accounting Symbol-Organization (PAS-ORG) Table. The proposed allocation algorithm requires factors based on annual operator attended times; this information is provided to the Office of VAMOSC by owning commands. Since this list of attended times has not yet been completely assembled, Operator Factors and costs cannot be computed, and the O&S Cost Reports currently show asterisks for this category.

a. Allocation Algorithm:

$$O_i = \sum_j O_{ij}$$

$$O_{ij} = O_j \times OF_{ij}$$

where O_i = the sum of allocated Operations Personnel costs for TMS_i at all organizations in the PAS-ORG Table,

O_{ij} = the allocated cost of Operations Personnel for TMS_i at $organization_j$,

O_j = the sum of all Operations Personnel costs for $organization_j$,

and OF_{ij} = the Operator Factor for TMS_i at $organization_j$.

The Operator Factors are developed as follows:

$$OF_{ij} = QOH_{ij} \times T_i/(OP_j \times H_{OP})$$

where QOH_{ij} = quantity of TMS_i on hand at $organization_j$,

T_i = the estimated number of operator hours required per year for TMS_i (Source: owning organizations),

OP_j = number of Operations Personnel at $organization_j$ (Source: C-E Manpower and Personnel Center (MPC) Extract Personnel File),

and H_{OP} = average annual available duty hours for a C-E operator as developed by the Office of VAMOSC.

b. Assumptions and Constraints:

1. It is not feasible to obtain actual attended times at each organization for each TMS requiring operator attention.

2. All equipment requiring operators is given the same amount of operator attention at all owning organizations.

3. Each TMS requiring operators requires operations personnel of the same grade with a similar pay rate.

c. Tables and Interfaces Required:

1. C-E MPC Extract Personnel File (PAS, Organization Code, FAC, AFSC, Grade, Number of Personnel).

2. Military and Civilian Pay Tables, AFR 173-13 (Grade, Standard Composite Pay Rates by Grade without Permanent Change of Station (PCS)).

3. D039 Format 100 Records (National Item Identification Number (NIIN), Organization Code, Quantity on Hand (QOH)).

4. TMS-NSN Table (TMS, NIIN).

5. Annual Operator Attended Time Table (TMS, Annual Operator Attended Time).

6. Estimated Annual Available Duty Hours for a C-E Operator.

2. Base Maintenance Personnel

Base Maintenance Personnel cost is the allocated cost of pay and allowances of personnel required for below depot maintenance for a specific C-E end item. Base Maintenance Personnel, by definition [24], include those C-E personnel who "repair, but do not operate, ground communication-electronics and meteorological (CEM) equipment."

a. Allocation Algorithm:

$$M_i = MC_i \times L_{Bi}$$

$$MC_i = \sum_j MC_{ij}$$

where M_i = allocated cost of base maintenance personnel for TMS_i,

MC_i = total Base Maintenance Personnel costs for personnel within the AFSC group assigned to TMS_i,

L_{Bi} = Base Labor Allocation Factor for TMS_i,

and M_{ij} = total Base Maintenance Personnel costs for personnel at $organization_j$ within the AFSC group assigned to TMS_i.

The Base Labor Allocation Factor for an end item is developed as follows:

$$LB_i = H_i/(N_i \times H_{ST})$$

where H_i = annual corrective plus Support General labor hours for all Standard Reporting Designators (SRDs) of TMS_i worldwide (Source: D056A),

N_i = total number of personnel in the C-E maintenance AFSC group assigned to TMS_i (Source: C-E MPC Extract Personnel File),

and H_{ST} = average annual available duty hours for a C-E maintenance person as developed by the Office of VAMOSC (current value: 1738 hours).

b. Assumptions:

1. Base Maintenance Personnel of a particular AFSC group are responsible for specific TMSs.

2. There is no more than one C-E Base Maintenance AFSC group assigned to each TMS.

c. Tables and Interfaces Required:

1. C-E MPC Extract Personnel File (PAS, Organization Code, FAC, AFSC, Grade, Number of Personnel).

2. Military and Civilian Pay Tables, AFR 173-13 (Grade, Standard Composite Pay Rates by Grade without PCS).

3. TMS-NSN Table (TMS, NIIN, AFSC, SRD).

4. Estimated Annual Available Duty Hours for C-E Maintenance Person.

5. D056A (Corrective and Support General Labor hours, SRD).

3. Administrative Personnel

Administrative Personnel Cost is the allocated cost of pay and allowances for personnel required at the organizational level for administrative support of a C-E end item at all C-E organizations in the PAS-ORG Table.

a. Allocation Algorithm:

$$A_i = \sum_j A_{ij}$$

$$A_{ij} = A_j \times fTMS_{ij}$$

where A_i = total Administrative Personnel cost allocated to TMS_i at all owning organizations in the PAS-ORG Table,

A_{ij} = Administrative Personnel costs allocated to TMS_i at $organization_j$,

A_j = the total cost of Administrative Personnel at $organization_j$,

and $fTMS_{ij}$ = the Unit TMS Allocation Factor for TMS_i at $organization_j$.

The Unit TMS Allocation Factors are developed as follows:

$$fTMS_{ij} = QOH_{ij} \times AC_i / \Sigma_i (QOH_{ij} \times AC_i)$$

where QOH_{ij} = the quantity of TMS_i in the inventory of organization $_j$ (Source: D039 Format 100 File),

and AC_i = the Air Force stock list price (Acquisition Cost) of TMS_i (Source: D039 Format 50 File).

b. Assumption:

The amount of Administrative Support required for a C-E end item at an organization is directly related to its inventory value relative to the inventory value of all other C-E end items at the organization.

c. Tables and Interfaces Required:

1. C-E MPC Extract Personnel File (PAS, Organization Code, FAC, AFSC, Grade, Number of Personnel).
2. Military and Civilian Pay Tables, AFR 173-13 (Grade, Standard Composite Pay Rates without PCS).
3. D039 Format 100 Records (NIIN, Organization Code, QOH).
4. TMS-NSN Table (TMS, NIIN).
5. D039 Format 50 Records (NIIN, Acquisition Cost).
6. PAS-ORG Table (PAS, Organization Code).

4. Supply Support Personnel

Supply Support Personnel include all organizational staff personnel who control materials used in the maintenance of C-E equipment. Supply Support Personnel cost is the allocated pay and allowances for personnel required to provide this kind of support for a C-E end item at all owning organizations in the PAS-ORG Table.

a. Allocation Algorithm:

$$S_i = \sum_j S_{ij}$$

$$S_{ij} = S_j \times f_{TMS_{ij}}$$

where S_i = total Supply Support Personnel cost allocated to TMS_i for all owning organizations in the PAS-ORG Table,

S_{ij} = Supply Support Personnel costs allocated to TMS_i at $organization_j$,

S_j = the sum of Supply Support Personnel costs for $organization_j$,

and $f_{TMS_{ij}}$ = the Unit TMS Allocation Factor for TMS_i at $organization_j$ (discussed previously).

b. Assumption:

The amount of Supply Support required for a C-E end item at an organization is directly related to its inventory value relative to the value of the inventory of all C-E end items at the organization.

c. Tables and Interfaces Required:

1. C-E MPC Extract Personnel File (PAS, Organization Code, FAC, AFSC, Grade, Number of Personnel).

2. Military and Civilian Pay Tables (Grade, Standard Composite Pay Rates by Grade without PCS).

3. D039 Format 100 Records (NIIN, Organization Code, QOH).

4. TMS-NSN Table (TMS, NIIN).

5. D039 Format 50 Records (NIIN, Acquisition Cost).

6. PAS-ORG Table (PAS, Organization Code).

B. UNIT LEVEL CONSUMPTION

The C-E system is designed to compute and provide separate visibility for three subcategories of costs under Unit Level Consumption. These are: Electric Utilities, Fuel, and Maintenance Material.

Currently, there is no algorithm for computing Fuel costs, and the C-E O&S Cost Reports show asterisks for this category. The cost allocation algorithms for the categories of Electric Utilities and Maintenance Materials are described in the following subsections.

1. Electric Utilities Cost

Electric Utilities cost is the cost of centrally produced or purchased electricity allocated to a C-E end item at all owning organizations on the PAS-ORG Table.

a. Allocation Algorithm:

$$U_i = \sum_j U_{ij}$$

$$U_{ij} = QOH_{ij} \times C_i \times R_j$$

where U_i = the allocated cost of electric utilities for TMS_i, for all owning organizations in the PAS-ORG Table,

U_{ij} = the allocated cost of electric utilities for TMS_i at $organization_j$,

QOH_{ij} = the quantity of TMS_i on hand at $organization_j$ (Source: D039 Format 100 File),

C_i = the annual electrical power consumption (KWH) of TMS_i (Source: Based on information from Technical Orders (TOs)),

and R_j = the base utility rate (cost per KWH) for $organization_j$ (Source: individual bases).

b. Assumptions:

1. All TMSs which consume electricity operate 24 hours a day, 365 days (8760 total hours) per year.

2. The power consumption rates obtained from TOs provide an accurate measure of the actual electrical power consumed by TMSs.

c. Tables and Interfaces Required:

1. D039 Format 100 File (Organization Code, NIIN, QOH).

2. TMS-NSN Table (TMS, NIIN, KWH).

3. Base Utility Rates.

4. PAS-ORG Table (PAS, Organization Code, GELOC (Geographic Location Code)).

2. Maintenance Material Cost

Maintenance Material cost is defined in AFR 400-31, Vol. III [24] as the "cost of materials consumed in the performance of base corrective maintenance for each C-E end item (TMS) at all C-E organizations at all bases." This includes AFSF (Air Force Stock Fund) costs in the General Support (Budget Code 9) and Systems Support Divisions (Budget Code 1).

a. Allocation Algorithm:

$$MM_i = \sum_k MM_{ik}$$

where MM_i = total base maintenance material costs for TMS_i, for all active duty organizations,

and MM_{ik} = base maintenance material cost for TMS_i with assigned SRD_k for all active duty organizations (Source: D002A).

b. Assumption:

The costs provided by the interface with the D002A system are only for C-E organizations in the PAS-ORG Table.

c. Tables and Interfaces Required:

1. D002A (NIIN, SRD, Cost, Quantity).
2. TMS-NSN Table (TMS, SRD).

C. DEPOT MAINTENANCE

Depot Maintenance includes the cost of depot-level maintenance and modification installations (other than conversions) for a TMS and its reparable components. This maintenance is performed at AF ALCs or other Department of Defense centralized repair facilities or by contractors. Also included are costs incurred by ALC Mobile Depot Maintenance teams or Air Force Communications Command (AFCC) Engineering and Installation (E&I) Teams.

a. Allocation Algorithm:

$$D_i = M_{dep_i} + M_{mob_i}$$

$$M_{dep_i} = \sum_m NC_m \times RAF_{im}$$

$$M_{mobi} = \sum_k M_{mob_{ik}}$$

where D_i = total Depot Maintenance cost allocated to TMS_i worldwide,

M_{dep_i} = total depot-level organic, interservice and contract cost allocated to TMS_i worldwide,

M_{mob_i} = total Mobile Depot Maintenance (MDM) cost, i.e., E&I Team cost, for TMS_i,

NC_m = total organic, interservice and contract depot maintenance cost (labor, materials, and other) for $NIIN_m$ (Source: H036B),

RAF_{im} = Recoverable Allocation Factor for $NIIN_m$ and its application TMS_i,

and $M_{mob_{ik}}$ = total MDM cost for SRD_k assigned to TMS_i (Source: C003K).

The Recoverable Allocation Factors (RAFs) for first level components are computed as follows:

$$RAF_{im} = QN_{im} \times A_{im} \times Q_i / \Sigma_i (QN_{im} \times A_{im} \times Q_i)$$

where QN_{im} = the quantity of $NIIN_m$ per end item installed in TMS_i (Source: D041A Format 50 File),

A_{im} = the percentage of the worldwide inventory of TMS_i in which $NIIN_m$ is installed (Source: D041A Format 50 File),

and Q_i = the average annual inventory of TMS_i Air Force-wide (Source: D039 Format 50 File).

To compute RAFs for recoverable components below the first level of indenture, Q_i in the above equation is replaced with the RAF numerator of the next higher application of the component.

b. Assumption:

A recoverable requires the same amount of repair regardless of its end item application.

c. Tables and Interfaces Required:

1. H036B (NIIN, Production Quantity, Cost).
2. TMS-NSN Table (TMS, NIIN, SRD).
3. D039 Format 50 File (NIIN, Average Annual Inventory).
4. C003K (SRD, Labor, Material, and Temporary Duty (TDY) cost).

5. D041A Format 50 File (Application NIIN, Recoverable NIIN, Quantity per Application (QPA), Application Percentage).

D. REPLACEMENT INVESTMENT

Replacement Investment is the cost of reparable spare parts for a TMS, not including the cost of initially procured reparable spares. The cost of recoverable spares is estimated by multiplying counts of base and depot-level condemnations by the unit prices of these items. These costs are allocated to end items with the same RAFs used to allocate depot maintenance costs.

a. Allocation Algorithm:

$$RI_i = \sum_m ((QCB_m + QCD_m) \times AC_m \times RAF_{im})$$

where RI_i = Replacement Investment cost for TMS_i,

QCB_m = quantity of $NIIN_m$ condemned at the base (Source: D041A Format 5 File),

QCD_m = quantity of $NIIN_m$ condemned at the depot (Source: D041A Format 8 File),

AC_m = Acquisition Cost of $NIIN_m$ (Source: D041A Format 1 File),

and RAF_{im} = Recoverable Allocation Factor for component $NIIN_m$ in TMS_i (defined previously).

b. Assumptions:

1. There is no significant salvage of reparable components from items condemned.

2. All parts which are condemned are replaced.

c. Tables and Interfaces:

1. D041A Format 1 File (NIIN, Unit Price).

2. D041A Format 5 File (NIIN, Base Condemnations).

3. D041A Format 8 File (NIIN, Depot Condemnations).

4. D041A Format 50 File (Application NIIN, Recoverable NIIN, QPA, Application Percentage).

5. D039 Format 50 File (NIIN, Average Annual Inventory).

6. *TMS-NSN Table (TMS, NIIN).*

E. INSTALLATION SUPPORT

There are three major categories of costs in Installation Support in the C-E system. These are BOS (Base Operating Support), RPM (Real Property Maintenance), and COM (Base Communications).

1. Base Operating Support

Base Operating Support costs in the C-E system are the indirect costs which result from providing various services to C-E mission personnel. These costs are defined in the C-E system as the costs reported in the H069R system

under Program Element Code (PEC) xxx96 for the eleven major commands (MAJCOMs) which report to VAMOSC.

a. Allocation Algorithm:

$$BOS_i = \sum_j BOS_{ij}$$

$$BOS_{ij} = BOS_j \times f_{TMS_{ij}}$$

$$BOS_j = TP_j \times BOSP$$

$$TP_j = OP_j + MP_j + AP_j + SP_j$$

$$BOSP = TBOS/WP$$

where BOS_i = total BOS costs for TMS_i for all owning organizations in the PAS-ORG Table,

BOS_{ij} = BOS costs allocated to TMS_i at organization$_j$,

BOS_j = total BOS costs allocated to organization$_j$,

$f_{TMS_{ij}}$ = Unit TMS Allocation Factor for TMS_i at organization$_j$ (defined previously),

TP_j = number of C-E personnel at organization$_j$,

BOSP = average BOS cost per person Air Force-wide,

OP_j = number of C-E Operations Personnel at organization$_j$ (Source: C-E MPC Extract Personnel File),

MP_j = number of C-E Base Maintenance Personnel at organization$_j$ (Source: C-E MPC Extract Personnel File),

AP_j = number of C-E Administrative Personnel at organization$_j$ (Source: C-E MPC Extract Personnel File),

SP_j = number of C-E Supply Support Personnel at organization$_j$ (Source: C-E MPC Extract Personnel File),

TBOS = total BOS (PEC xxx96) costs for all eleven major commands which report to VAMOSC (Source: H069R),

and WP = Number of AF personnel worldwide (Source: C-E MPC Extract Personnel File).

b. Assumptions:

1. BOS costs for a C-E organization are directly related to the number of C-E personnel at the organization.

2. BOS costs are independent of the location of the organization.

3. BOS costs for a C-E end item at an organization are directly related to its inventory value relative to the value of the inventory of all other C-E equipment owned by the organization.

c. Tables and Interfaces Required:

1. H069R (PEC, cost).

2. C-E MPC Extract Personnel File (PAS, FAC, AFSC, Number of Personnel).

3. D039 Format 100 Record (NIIN, QOH, Organization Code).

4. D039 Format 50 Record (NIIN, Acquisition Cost).

5. TMS-NSN Table (TMS, NIIN).

6. PAS-ORG Table (PAS, Organization Code).

2. Real Property Maintenance

Real Property Maintenance costs for a C-E end item are the allocated costs for resources specifically identified and measurable to civil engineers and civil engineering squadrons for services related to the operation and maintenance of real property facilities. These costs are defined in the C-E

system as the costs for all services reported in H069R under PEC xxx94 for the eleven MAJCOMs which report to VAMOSC.

a. Allocation Algorithm:

$$RPM_i = \sum_j RPM_{ij}$$

$$RPM_{ij} = RPM_j \times f_{TMS_{ij}}$$

$$RPM_j = TP_j \times RPMP$$

$$TP_j = OP_j + MP_j + AP_j + SP_j$$

$$RPMP = TRPM/WP$$

where RPM_i = RPM costs allocated to TMS_i for all owning organizations in the PAS-ORG Table,

RPM_{ij} = RPM costs allocated to TMS_i at $organization_j$,

RPM_j = RPM costs allocated to $organization_j$,

$f_{TMS_{ij}}$ = Unit TMS Allocation Factor for TMS_i at $organization_j$ (defined previously),

TP_j = number of C-E personnel at $organization_j$,

RPMP = average RPM cost per person worldwide,

OP_j = number of Operations Personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

MP_j = number of Base Maintenance Personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

AP_j = number of Administrative Personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

SP_j = number of Supply Support personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

TRPM = total RPM (PEC xxx94) costs for all eleven major commands which report to VAMOSC (Source: H069R),

and WP = total number of AF personnel worldwide (Source: C-E MPC Extract Personnel File).

b. Assumptions:

1. RPM costs for a C-E organization are directly related to the number of C-E personnel at the organization.

2. RPM costs are independent of the location of the organization.

3. RPM costs for a C-E end item at a C-E organization are directly related to its inventory value relative to the inventory value of all other C-E equipment owned by the organization.

c. Tables and Interfaces Required:

1. H069R (PEC, cost).

2. C-E MPC Extract Personnel File (PAS, FAC, AFSC, Number of Personnel).

3. D039 Format 100 File (NIIN, QOH, Organization Code).

4. D039 Format 50 File (NIIN, Acquisition Cost).

5. TMS-NSN Table (TMS, NIIN).

6. PAS-ORG Table (PAS, Organization Code).

3. Base Communications

Base Communication costs in the C-E system are the allocated cost of non-Defense Communications Systems (non-DCS) communications resources to support a command's base communications requirements. These costs are defined by the C-E system as the costs for all services reported in H069R under PEC

xxx95, or PEC 33112 with Responsibility Center/Cost Center (RC/CC) codes of xx26xx or xx38xx for the eleven MAJCOMs which report to VAMOSC.

a. Allocation Algorithm:

$$COM_i = \sum_j COM_{ij}$$

$$COM_{ij} = COM_j \times f_{TMS_{ij}}$$

$$COM_j = TP_j \times COMP$$

$$TP_j = OP_j + MP_j + AP_j + SP_j$$

$$COMP = TCOM/WP$$

where COM_i = COM costs allocated to TMS_i for all owning organizations in the PAS-ORG Table,

COM_{ij} = COM costs allocated to TMS_i at $organization_j$,

COM_j = COM costs allocated to $organization_j$,

$f_{TMS_{ij}}$ = Unit TMS Allocation Factor for TMS_i at $organization_j$ (defined previously),

TP_j = number of C-E personnel at $organization_j$,

COMP = average COM cost per person Air Force-wide,

OP_j = number of Operations Personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

MP_j = number of Base Maintenance Personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

AP_j = number of Administrative Personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

SP_j = number of Supply Support personnel at $organization_j$ (Source: C-E MPC Extract Personnel File),

TCOM = total COM (PEC xxx95, PEC 33112 with RC/CC xx26xx or xx38xx) costs summed for the eleven MAJCOMs which report to VAMOSC

(Source: H069R),

and WP = total number of AF personnel worldwide (Source: C-E MPC Extract Personnel File).

b. Assumptions:

1. COM costs for a C-E organization are directly related to the number of C-E personnel at the organization.

2. COM costs are independent of the location of the organization.

3. COM costs for a C-E end item at an organization are directly related to its inventory value relative to the value of the inventory of all other C-E equipment at the organization.

c. Tables and Interfaces Required:

1. H069R (PEC, RC/CC, cost).

2. C-E MPC Extract Personnel File (PAS, FAC, AFSC, Organization Code, Number of Personnel).

3. D039 Format 100 File (NIIN, QOH, Organization Code).

4. D039 Format 50 File (NIIN, Acquisition Cost).

5. TMS-NSN Table (TMS, NIIN).

6. PAS-ORG Table (PAS, Organization Code).

F. INDIRECT PERSONNEL

There are three categories of Indirect Personnel costs in the C-E system. They are Temporary Duty (TDY), Medical and Permanent Change of Station (PCS).

1. Temporary Duty

Temporary Duty costs are the allocated cost associated with temporary duty for C-E unit mission personnel. Temporary duty covers the movement of individuals to a different duty station for a specific period of time (not to exceed 89 days), followed by a return to the original or new permanent duty station. These costs are obtained from H069R by Reporting Operating Agency/Operating Budget Account Number (OAC/OBAN).

a. Allocation Algorithm:

$$TDY_i = \sum_j TDY_{ij}$$

$$TDY_{ij} = TDY_j \times f_{TMSij}$$

$$TDY_j = TDY_t \times PAF_{jt}$$

where TDY_i = TDY cost allocated to TMS_i for all owning organizations in the PAS-ORG Table,

TDY_{ij} = TDY cost allocated to TMS_i at $organization_j$,

TDY_j = TDY cost for $organization_j$,

f_{TMSij} = Unit TMS Allocation Factor for TMS_i at $organization_j$ (defined previously),

TDY_j = total TDY cost for reporting $OAC/OBAN_t$ (Source: H069R),

and PAF_{jt} = PAS Allocation Factor for $organization_j$ with reporting $OAC/OBAN_t$.

The PAS Allocation Factor is developed as follows:

$$PAF_{jt} = TP_{jt} / TP_t$$

where TP_{jt} = number of personnel at organization$_j$ with reporting OAC/OBAN$_t$ (Source: C-E MPC Extract Personnel File),

and TP_t = number of personnel for all PASs with reporting OAC/OBAN$_t$ (Source: C-E MPC Extract Personnel File).

b. Assumption:

The value of the inventory of a C-E end item at an organization relative to the value of the inventory of all C-E equipment at the organization is an appropriate basis for allocation of TDY costs to a TMS.

c. Tables and Interfaces Required:

1. H069R (OAC/OBAN, Element of Expense/Investment Code (EEIC), cost).
2. C-E MPC Personnel Extract File (PAS, Number of Personnel).
3. D039 Format 50 File (NIIN, Acquisition Cost).
4. D039 Format 100 File (NIIN, Organization Code, QOH).
5. OAC/OBAN Table (Reporting OAC/OBAN).
6. PAS-ORG Table (PAS, Organization Code).
7. TMS-NSN Table (TMS, NIIN).
8. Unit Factor Table (PAS, Reporting OAC/OBAN).

2. Medical (Health Care)

Medical costs are the allocated cost of medical and dental care to

support military personnel at their peacetime location. A medical/dental cost per military person Air Force-wide is received annually from the Office of the Air Force Surgeon General (HQ USAF/SGMC). This factor is used to compute medical costs for military C-E mission personnel. Medical costs for the four categories of C-E Unit Mission Personnel are allocated to TMSs in the same manner as are their pay and allowances. Medical costs for Operations Personnel currently are not processed by the C-E system.

a. Allocation Algorithm:

$$MED_i = MED_{Mi} + \sum_j (MED_{Oij} + MED_{Aij} + MED_{Sij})$$

$$MED_{Mi} = MEDMC_i \times L_{Bi}$$

$$MED_{Oij} = MED_{OPj} \times OF_{ij}$$

$$MED_{Aij} = MED_{APj} \times f_{TMSij}$$

$$MED_{Sij} = MED_{SPj} \times f_{TMSij}$$

where MED_i = Medical costs allocated to TMS_i,

MED_{Mi} = Medical costs for military C-E Base Maintenance Personnel allocated to TMS_i,

MED_{Oij} = Medical costs for military C-E Operations Personnel in $organization_j$ allocated to TMS_i,

MED_{Aij} = Medical costs for military C-E Administrative Personnel in $organization_j$ allocated to TMS_i,

MED_{Sij} = Medical costs for military C-E Supply Support Personnel in $organization_j$ allocated to TMS_i,

MED_{MCi} = Medical costs for military C-E Base Maintenance Personnel in the maintenance AFSC group assigned to TMS_i (Source: C-E MPC Extract Personnel File),

L_{Bi} = Base Labor Allocation Factor for TMS_i (defined previously),

MED_{OPj} = Medical costs for military C-E Operations Personnel in $organization_j$ (Source: C-E MPC Extract Personnel File),

OF_{ij} = Operator Factor for TMS_i in $organization_j$ (defined previously),

MED_{APj} = Medical costs for military C-E Administrative personnel in $organization_j$ (Source: C-E MPC Extract Personnel File),

f_{TMSij} = Unit TMS Allocation Factor for TMS_i in $organization_j$ (defined previously),

and MED_{SPj} = Medical costs for military C-E Supply Support Personnel in $organization_j$ (Source: C-E MPC Extract Personnel File).

b. Assumptions:

1. Medical costs are independent of the geographical distribution of C-E personnel.

2. Assumptions pertaining to the factors for allocating pay and allowances for the Unit Mission Personnel categories (discussed previously).

c. Tables and Interfaces Required:

1. C-E MPC Extract Personnel File (FAC, PAS, AFSC, Grade, Number of Personnel).

2. D039 Format 50 File (NIIN, Acquisition Cost).

3. D039 Format 100 File (NIIN, Organization Code, QOH).

4. D056A (SRD, Labor Hours).

5. PAS-ORG Table (PAS, Organization Code).

6. TMS-NSN Table (TMS, NIIN, SRD).

3. Permanent Change of Station

Permanent Change of Station costs are the allocated cost of moving C-E military mission personnel in connection with a permanent change of duty station. As with Medical and TDY costs, PCS costs are not currently processed for Operations Personnel in the C-E system.

The initial steps in the development of PCS costs for C-E are done in VAMOH using a PCS Cost Table from HQ AF/MPPB [17]. This table contains Average PCS cost per move by type-PCS/grade type combination. Costs are computed for military personnel records in the E300Z file received if the reported Date-Arrived-on-Station is within the previous FY. These computed PCS costs are appended to personnel records for the C-E MPC Extract Personnel File.

a. Allocation Algorithm:

$$PCS_i = PCS_{Mi} + \sum_j (PCS_{Oij} + PCS_{Aij} + PCS_{Sij})$$

$$PCS_{Mi} = PCS_{MPi} \times L_{Bi}$$

$$PCS_{Oij} = PCS_{OPj} \times OF_{ij}$$

$$PCS_{Aij} = PCS_{APj} \times f_{TMSij}$$

$$PCS_{Sij} = PCS_{SPj} \times f_{TMSij}$$

where PCS_i = PCS costs allocated to TMS_i,

PCS_{Mi} = PCS costs for military C-E Base Maintenance Personnel allocated to TMS_i,

PCS_{Oij} = PCS costs for military C-E Operations Personnel in $organization_j$ allocated to TMS_i,

PCS_{Aij} = PCS costs for military C-E Administrative Personnel in $organization_j$ allocated to TMS_i,

PCS_{Sij} = PCS costs for military C-E Supply Support Personnel in $organization_j$ allocated to TMS_i,

PCS_{MPi} = PCS costs for military C-E Base Maintenance Personnel in the maintenance AFSC group assigned to TMS_i (Source: C-E MPC Extract Personnel File),

L_{Bi} = Base Labor Allocation Factor for TMS_i (defined previously),

PCS_{OPj} = PCS costs for military C-E Operations Personnel in $organization_j$ (Source: C-E MPC Extract Personnel File),

OF_{ij} = Operator Factor for TMS_i in $organization_j$ (defined previously),

PCS_{APj} = PCS costs for military C-E Administrative Personnel in $organization_j$ (Source: C-E MPC Extract Personnel File),

f_{TMSij} = Unit TMS Allocation Factor for TMS_i at $organization_j$ (defined previously),

and PCS_{SPj} = PCS costs for military C-E Supply Support Personnel in $organization_j$ (Source: C-E MPC Extract Personnel File).

b. Assumptions:

1. PCS costs for moves accomplished during the change in FY will be negligible over time.

2. The mix of military and civilian personnel is independent of the type of equipment being costed.

3. Assumptions pertaining to the allocation of pay and allowances for the Unit Mission Personnel categories, discussed previously.

c. Tables and Interfaces Required:

1. C-E MPC Extract Personnel File (PAS, FAC, AFSC, Number of Personnel, Grade, PCS Cost).
2. D039 Format 50 File (NIIN, Acquisition Cost).
3. D039 Format 100 File (NIIN, Organization Code, QOH).
4. D056A (SRD, Labor Hours).
5. PAS-ORG Table (PAS, Organization Code).
6. TMS-NSN Table (TMS, NIIN, SRD).

G. C-E DEPOT NON-MAINTENANCE

There are three categories of costs in Depot Non-Maintenance in the C-E system. They are General Depot Support (GDS), Engineering Support, and Transportation and Packaging (T&P).

1. General Depot Support

General Depot Support costs in the C-E system are the costs of functions which are not a part of depot maintenance, but support depot maintenance activity. GDS costs are obtained from H069R; they consist of costs for certain 63xx OAC/OBANs at SM-ALC for PECs 71111, 71112, and 71113. These PECs cover material distribution, material management, and material procurement, respectively.

a. Allocation Algorithm:

$$GDS_i = (GC_1 + GC_2 + GC_3) \times FTMS_i$$

where GDS_i = General Depot Support cost allocated to TMSi for all organizations in the PAS-ORG Table,

GC_1 = Portion of the material distribution cost (PEC 71111) from SM-ALC allocated by VAMOH to C-E activities (Source: H069R),

GC_2 = Portion of the material management cost (PEC 71112) from SM-ALC allocated by VAMOH to C-E activities (Source: H069R),

GC_3 = Portion of the procurement management cost (PEC 71113) from SM-ALC allocated by VAMOH to C-E activities (Source: H069R),

and $FTMS_i$ = Worldwide TMS Allocation Factor for TMSi.

The Worldwide TMS Allocation Factor for each end item is developed as follows:

$$FTMS_i = QOH_i \times AC_i / \sum_i (QOH_i \times AC_i)$$

where QOH_i = quantity of TMS_i on hand at all organizations in the PAS-ORG Table (Source: D039 Format 100 File),

and AC_i = the Air Force stock list price of TMS_i (Source: D039 Format 50 File).

b. Assumptions:

1. C-E equipment is managed only at SM-ALC.
2. The appropriate amount of General Depot Support costs from SM-ALC are being allocated to C-E activities.
3. The value of a C-E end item's inventory, relative to the inventory

value of all C-E end items for all organizations on the PAS-ORG Table, is an appropriate cost driver for allocating General Depot Support costs to the end item.

c. Tables and Interfaces Required:

1. H069R (OAC/OBAN, PEC, cost).
2. D039 Format 100 File (QOH, NIIN).
3. D039 Format 50 File (Acquisition Cost, NIIN).
4. TMS-NSN Table (TMS, NIIN).

2. Engineering Support

Engineering Support costs are the allocated costs of depot-level contracted service engineering for safe system operation. These costs are obtained from SM-ALC already allocated to TMSs within the particular system to which they apply.

3. Transportation and Packaging

Transportation and Packaging (T&P) costs are the allocated direct costs of transporting all recoverable assemblies and/or end items to depots for service and back to the user. Also included is the one-way transportation cost of replacement recoverable assemblies shipped from supply points to base maintenance organizations.

a. Allocation Algorithm:

$$TTP_i = \sum_m TP_{im}$$

$$TP_{im} = (WR_m \times f_{pw} \times f_{tp} [2(QD_m + QNR_m) + QB_m]) \times RAF_{im}.$$

where TTP_i = T&P cost allocated to TMS_i and all of its recoverables worldwide,

TP_{im} = T&P cost for $NIIN_m$ allocated to TMS_i,

WR_m = Packaged Weight of $NIIN_m$ (Source: 0013),

f_{pw} = Packaged Weight/Item Weight Factor (Source: AFLCP 173-10 [1]),

f_{tp} = T&P cost per pound (Source: AFLCP 173-10),

QD_m = quantity of recoverable $NIIN_m$ condemned at the depot (Source: D041 Format 8 records),

QNR_m = quantity of $NIIN_m$ repaired at the depot (Source: H036B),

QB_m = quantity of recoverable $NIIN_m$ condemned at the base (Source: D041 Format 5 records),

and RAF_{im} = the Recoverable Allocation Factor for $NIIN_m$ and TMS_i (defined previously).

b. Assumptions:

Transportation and Packaging costs are directly related to the weight of an item.

c. Tables and Interfaces Required:

1. 0013 (NIIN, Packaged Weight).
2. AFLC Cost and Planning Factors [1] (NIIN, Packaging Cost Per Pound,

Transportation Cost Per Pound, Packaged Weight/Item Weight Factor).

3. D041 Format 8 File (NIIN, Number of Depot Condemnations).

4. D041 Format 5 File (NIIN, Number of Base Condemnations).

5. H036B (NIIN, Production Quantity).

6. TMS-NSN Table (TMS, NIIN).

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